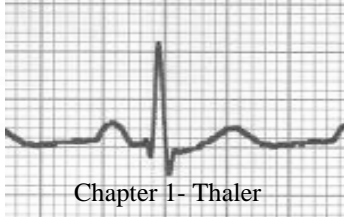


## ***Electrophysiology Introduction, Basics***



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## **The Myocardial Cell**

- Syncytium
- Resting state
  - Polarized – negative
  - Membrane pump
- Depolarization – fundamental electrical event of the heart
- Repolarization – restoration of resting polarity (See pg 11, Thaler)

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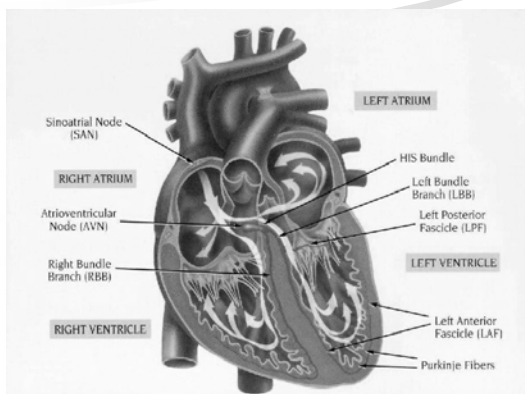
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## Types of cells in the heart

- Pacemaker cells
  - 5 – 10  $\mu\text{m}$  in length;
    - Sinoatrial and atrioventricular nodes
  - Spontaneous depolarization
  - Action Potential
- Electrical conducting cells
  - Long thin cells
    - Atrial conducting system
    - Ventricular conducting system

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## Types of cells in the heart (con't)

- Myocardial cells
  - Contractile units in the heart, most are myocardial cells
  - Calcium is responsible for contractile process after initiation of action potential

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## Rules of ECG

- Wave of depolarization traveling towards a positive electrode causes an upward deflection on the ECG
- Wave of depolarization traveling away from a positive electrode causes a downward deflection on the ECG
- Biphasic Wave

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### Rules of ECG (con't)

- Wave of Repolarization traveling away from a positive electrode causes an upward deflection on the ECG
- Wave of repolarization traveling towards a positive electrode causes. . . . . ?

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Happy Halloween



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### Quiz (no grade)

- What is the first “basic” rule of ECG?
- List the components of the electrical conduction system starting from the atrial chambers?
- *(haven't covered this one yet)* The vertical axis on an ECG paper represents the \_\_\_\_ component.

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## Time and voltage

- ECG – waves are primarily from myocardial cell activity
  - Characteristics of ECG recordings
    - Duration
    - Amplitude
    - Configuration
  - EKG paper
    - Lines
    - Squares
    - Vertical Axis

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## Segments and Intervals

- *Segment* – strait line between waves
- *Interval* – wave plus a segment
- *PR interval* – 0.12 – 0.20 msec
- *ST segment* – end of ventricular depolarization to start of vent. repolarization
- *QT interval* – ventricular cycle, 40% of each cardiac cycle

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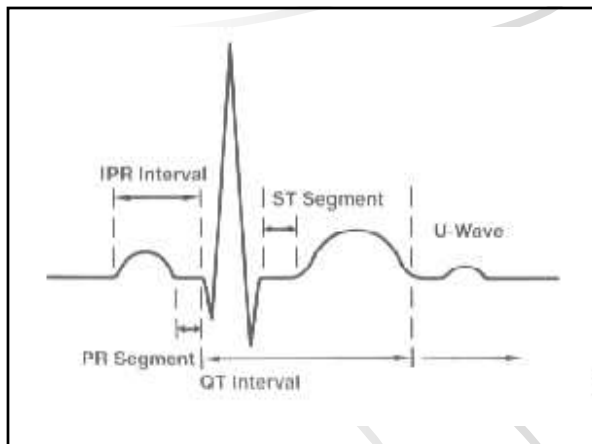
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## Atrial Depolarization

- P wave – small, round deflection on the ECG
  - Right atrial component
  - Left atrial component
  - Normal amplitude –  $\leq 0.25$  mV (2.5 mm)
  - Normal duration – 0.04 – 0.12 msec
- AV node conduction pause

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## Ventricular Depolarization

- Includes
  - bundle of His
  - Bundle Branches
    - Right
    - Left
      - Septal
      - Anterior
      - Posterior
  - Terminal Purkinje fibers

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## Ventricular Depolarization

- Ventricular Waves
  - Q wave – first downward deflection after P wave
  - R wave – first upward deflection after Q wave
  - R' wave – any second upward deflection
  - S wave – first downward deflection after the R wave
- QRS duration – 0.06 to 0.12 msec
- QRS configurations

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## Ventricular Repolarization

- T wave
  - “small to moderate” size positive deflection wave after the QRS complex,
  - Height is 1/3 to 2/3 that of the corresponding R wave
- U wave
  - Septal repolarization (not always seen on ECG)

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## The 12-lead ECG

- Based on looking at the heart from 12 different angles (taking 12 different snapshots of the heart)
- Formulated by 10 electrodes
  - 4 limb electrodes (6 limb leads)
    - 3 standard
    - 3 augmented
  - 6 precordial electrodes (6 precordial leads)

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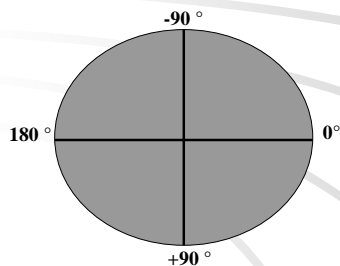
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## Limb Leads

- Viewing the myocardium in a vertical plane with degrees of 0 to 180 and 0 to -179.



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### Limb leads (con't)

- Standard limb leads – combination of 2 electrodes one (+) and one (-), each with its respective angle of orientation (A of O)
  - Lead I: RA(-), LA(+), A of O =  $0^{\circ}$
  - Lead II: RA (-), LL (+), A of O =  $+60^{\circ}$
  - Lead III: LA (-), LL (+), A of O =  $+120^{\circ}$

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### Limb leads (con't)

- Augmented leads – formed by making a central “lead” positive and all other are negative
  - Lead avL – LA (+), A of O =  $-30^{\circ}$
  - Lead avR – RA (+), A of O =  $-150^{\circ}$
  - Lead avF – LL (+), A of O =  $+90^{\circ}$

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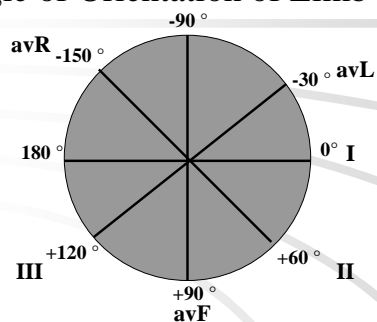
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### Angle of Orientation of Limb Leads




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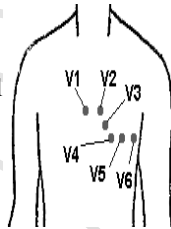
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### Precordial Leads

- Chest leads which view the heart in a horizontal plane and analyze forces in a anterior/posterior orientation
- ECG system designates a central pole with each of 6 electrodes being positive



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### Precordial Leads (con't)

- V1 – 4<sup>th</sup> intercostal space to rt of sternum
- V2 – 4<sup>th</sup> intercostal space to lt of the sternum
- V3 – between V2 and V4
- V4 – 5<sup>th</sup> intercostal space midclavicular line
- V5 – anterior axillary line, in line with V4
- V6 – midaxillary line, in line with V4

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### Anterior, Posterior, Lateral, Inferior Views

- Anterior – V1 – V4
- Left Lateral – I, avL, V5 and V6
- Inferior – II, III, and avF
- Posterior – avR, reciprocal changes in V1

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## **Vectors and Axis Determination in the Heart**

- Refers to orientation of the sum of all cardiac vectors in the heart
- Axis –angle of orientation of the main cardiac vector (Limb Leads)
  - Normal : between  $-10$  degrees to  $+100$  degrees
- Transition zone – refers to R wave progression in precordial leads

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